CONCEPTS OF EARLY TAPEWORM DEVELOPMENT DERIVED FROM COMPARATIVE EMBRYOLOGY OF ONCHOSPHERES

BY

ROBERT EDWARD OGREN

B. A., Wheaton College, 1947

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CONCEPTS OF TAPEWORM DEVELOPMENT DERIVED FROM COMPARATIVE EMBRYOLOGY OF ONCHOSPHERES

Review of literature on cestode embryology reveals a definite lack of current research. Embryologies now used in invertebrate and parasitology texts are based on work by Schauinsland in 1886, Janicki in 1907, and Spätlich in 1925. The entire field is in need of new orientation, new terms, and detailed descriptive studies. Knowledge of the onchosphere, or infective embryo, is similarly inadequate. The most detailed accounts are by European writers describing Pseudophyllidea. The papers by Vogel, and by Wisniewski in 1930, and by Michajlow in 1933 are the primary literature references.

In tapeworm embryology the first cleavage is equal. The second cleavage is also equal but takes place early in one blastomere and late in the other. The third cleavage is slightly unequal producing a macromere and a micromere, and occurs in one macromere earlier than the three others. A stereoblastula, or solid blastula, is formed which develops into a stereogastrula, or solid gastrula, identified by the presence of an epidermis (ectoderm) enclosing the ectomesoderm into which entomesoderm cells proliferate from the presumptive anterior region.

In order to facilitate description and account for differences in cestode stereogastrulae, the following new terms are suggested:

1) An *embryophore-stereogastrula* is covered by a detached embryophore or epidermis composed of a few squamous cells. This structure is membranous and surrounds the onchosphere, or inner cell mass bearing six hooks (hexacanth embryo). The onchosphere is composed of ectomesoderm (somatic cells) and contains a few to many large entomesoderm cells (plastin cells) situated in the presumptive anterior region.

2) A *ciliaphore-stereogastrula* consists of a detached, ciliated epidermis. The onchosphere contains two flame cells, ecto-

mesoderm and entomesoderm.

3) An *onchosphere-stereogastrula* is essentially an onchosphere from which the epidermis has not detached to form an embryophore. Epidermal cells become filled with active granules involved in membrane formation and form structures termed *granulation zones* (Reid's glands). Six hooks, ectomesoderm, and entomesoderm are present as in other onchospheres.

There are two basic patterns of tapeworm development characterized by type of oocyte, early embryology and distinct larval stages.

1) Cestodes with Cyclophyllidean Development have oocytes with conglomerate-cytoplasm containing large irregular masses of vitelline substance. Only one-half of the zygote takes part in forming the embryo. The larval cestode is a cysticercus, or cysticercoid. Only embryophore - stereogastrulae and onchosphere - stereogastrulae have been found in the Cyclophyllidea.

2) Cestodes with Pseudo-Tetra-phyllidean Development have oocytes with granular-cytoplasm, containing coarse vitelline granules. The entire zygote forms the embryo. The larval cestode first to develop is a procercoid which differentiates into one of several kinds of plerocercoids. Embryophore-stereogastrulae, and ciliaphore-stereogastrulae are found in the orders Pseudophyllidea and Tetrarhynchidea, but only embryophore-stereogastrulae in the Tetraphyllidea.

Embryologies of the following species are described for the first time: *Mesocestoides variabilis, Raillietina echinobothrida, Paranoplocephala variabilis, Hymenolepis nana, Microstrobila succincta* n. g. n. sp., *Oochoristica ratti, Dictymetra paranumenii, Choanotaenia iola, Proteocephalus* sp. Corrections or additional descriptions are made for the following: *Taenia, Dipylidium, Cylindrotaenia.*

New and additional figures are presented on the development of the cysticercoid of *Oochoristica ratti* in the meal beetle. It was demonstrated that the entomesoderm differentiated into the tissues of this metacestode.

Preliminary work on the behavior of cestode muscle fibers *in vivo* are described. The fibers bend and become wavy, or thicken during contraction. Cestode muscle is slow "smooth" muscle, rich in sarcoplasm, with a high chronaxie and a very low fusion frequency. A long duration for threshhold stimulation is required. Relaxation time is very much longer than contraction time.

Several theoretical principles are developed.

1) The embryonic presumptive anterior region of the onchosphere is homologous with the presumptive anterior of Protostomia.

2) Granular regions in the cortex of certain onchospheres are not "penetration glands" but several granule filled cortical cells, associated with membrane and cuticle formation.

3) Muscle fibers of the metacestode and adult are formed by fusion of protoplasmic processes from stellate myoblasts around the contractile fiber bundle.

4) The body covering of tapeworms consists of cuticular substance continuously forced through the cortex, deposited and solidified in layers over the surface.

5) The musculature of the onchosphere consists of contractile corticle and parenchymal cells, which produce constricting waves and local movements.

6) Ciliaphore-stereogastrulae characteristically have flame cells in the onchosphere. Other stereogastrulae do not develop flame cells until the procercoid or cysticercoid or cysticercus differentiates.

7) Taxonomic distinctions can be made using appropriate knowledge of embryology and developmental stages.

8) Tapeworm physiology requires a cellular approach. The entomesoderm cells forming the body tissue of the metacestode and adult are independent metabolic units. Liquids containing nutritive products from the host's intestine, or body cavity, diffuse through the cuticle and are received by the body cells of the tapeworm.

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VITA

Robert Edward Ogren was born on February 9, 1922, in Jamestown, New York. After graduating from Jamestown Senior High School in 1940, he entered Wheaton College, Wheaton, Illinois. He enlisted in the Army of the United States in 1943 and served in the Pacific Theater. Upon discharge from the Army in 1946 he returned to Wheaton College and received the degree of Bachelor of Arts from that institution in June, 1947. In September, 1947, he entered Northwestern University, where he did graduate study and laboratory assisting. He received the degree of Master of Science in August, 1948. He then entered the Graduate College of the University of Illinois and held a half-time assistantship from September, 1948, to June, 1953. He conducted preliminary research on oyster parasites at the Chesapeake Biological Station during the summer of 1951. He is a member of the following scientific societies: American Society of Parasitologists, American Microscopical Society, Society of the Sigma XI, Phi Sigma. He has published the following research.

Ogren, R. E., 1950, Morphological observations on the onchosphere of *Mesocestoides*, *J. Parasitol.*, 36, 87.

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He has presented the following abstracts of research being prepared for publication:

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